



TCS
Preliminary Design Review

Software
Top Level Design
Section 3

04 February 1997

**NAVAL SURFACE WARFARE CENTER
DAHLGREN DIVISION**



Agenda

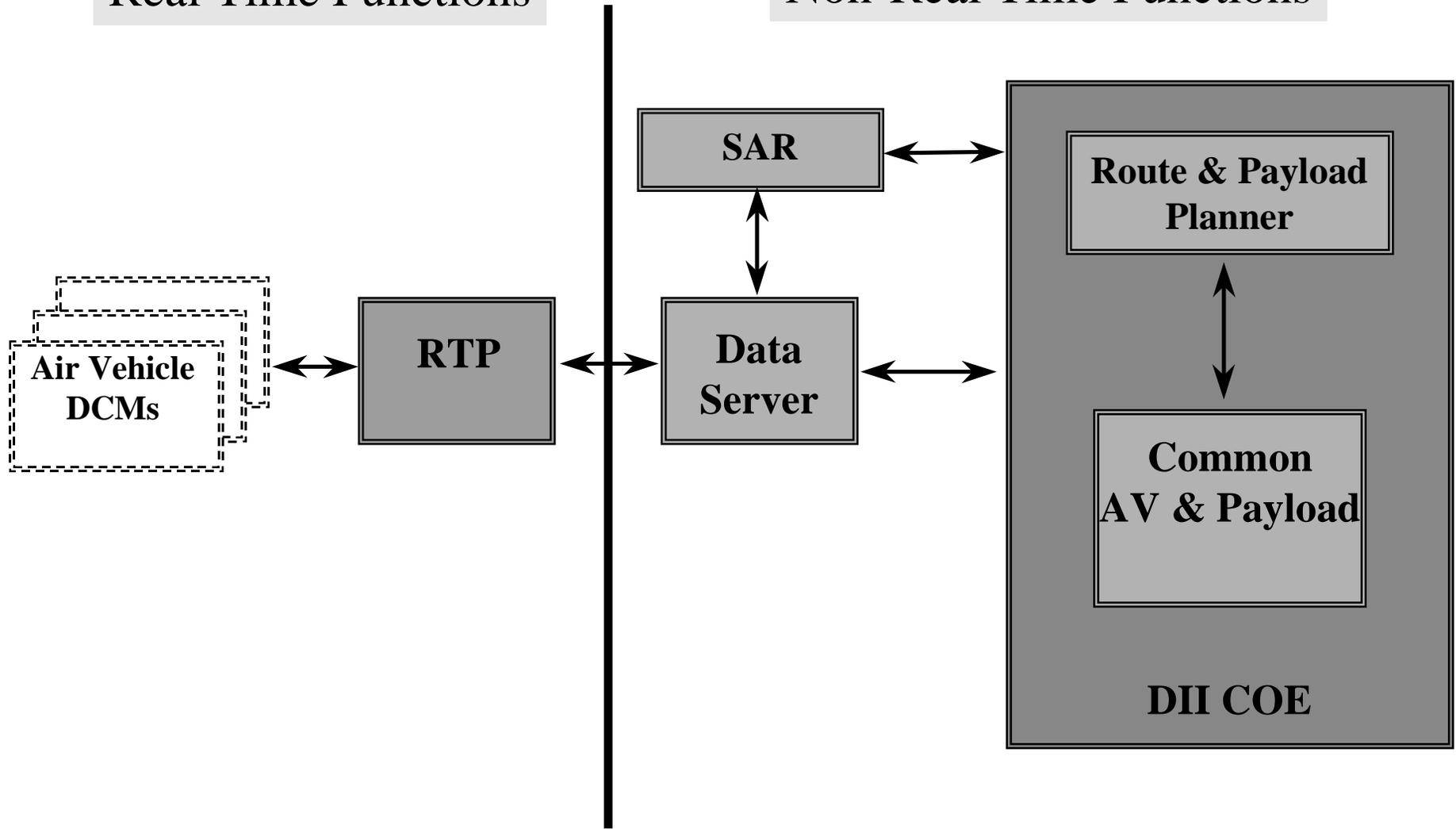
- PDR Part I Review
- Operational Model
- Target Configuration/Environment
- Top Level Design
 - Section 1: CSCIs Overview
 - Section 2: DCM CSCIs
 - Section 3: RTP CSCI
 - Section 4: DataServer CSCI
 - Section 5: DII CSCI
 - Section 6: Route & Payload Planner CSCI
 - Section 7: Common AV & Payload CSCI



TCS Block 0 CSCI Diagram

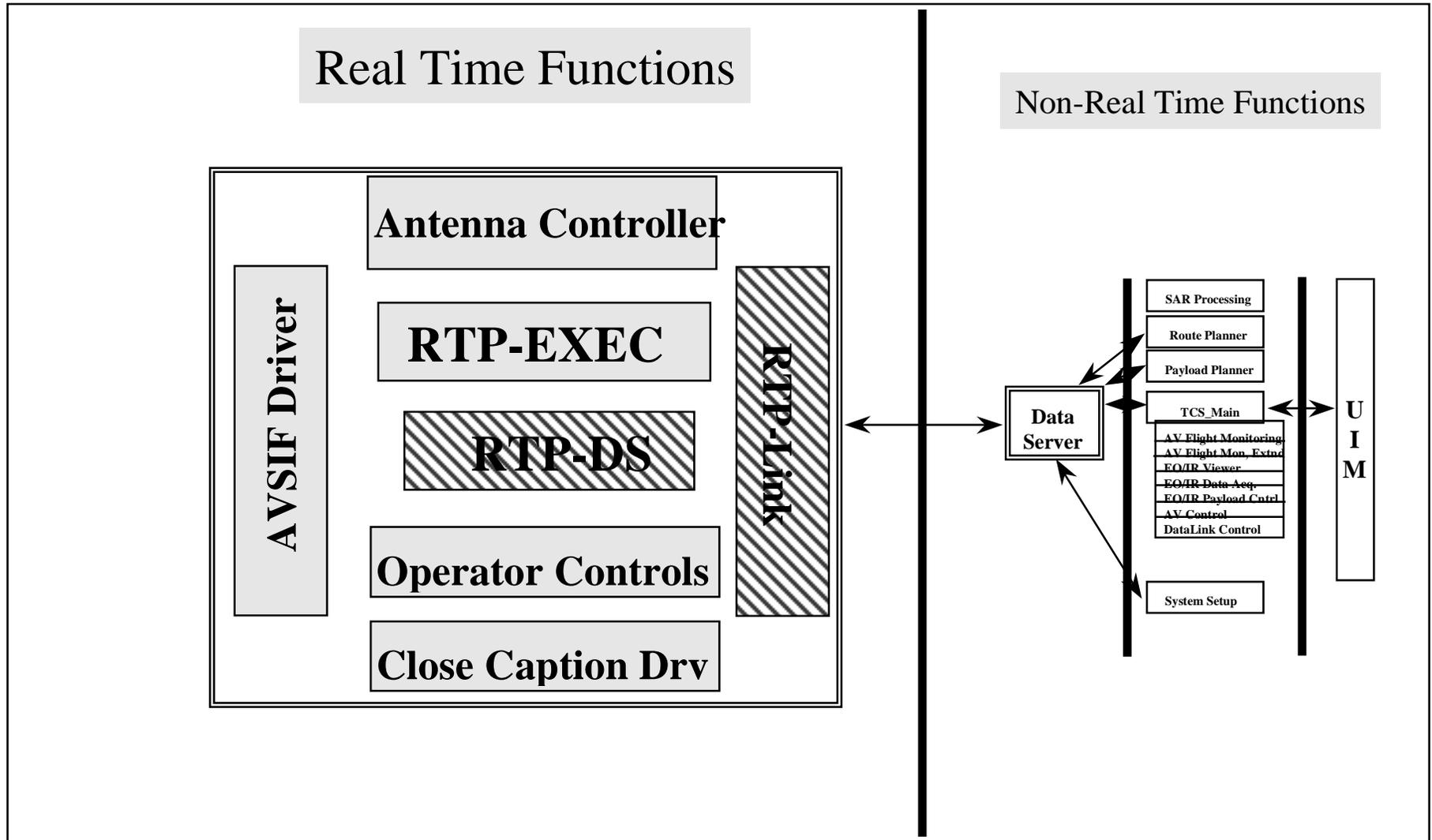
Real Time Functions

Non-Real Time Functions





RTP Block Diagram



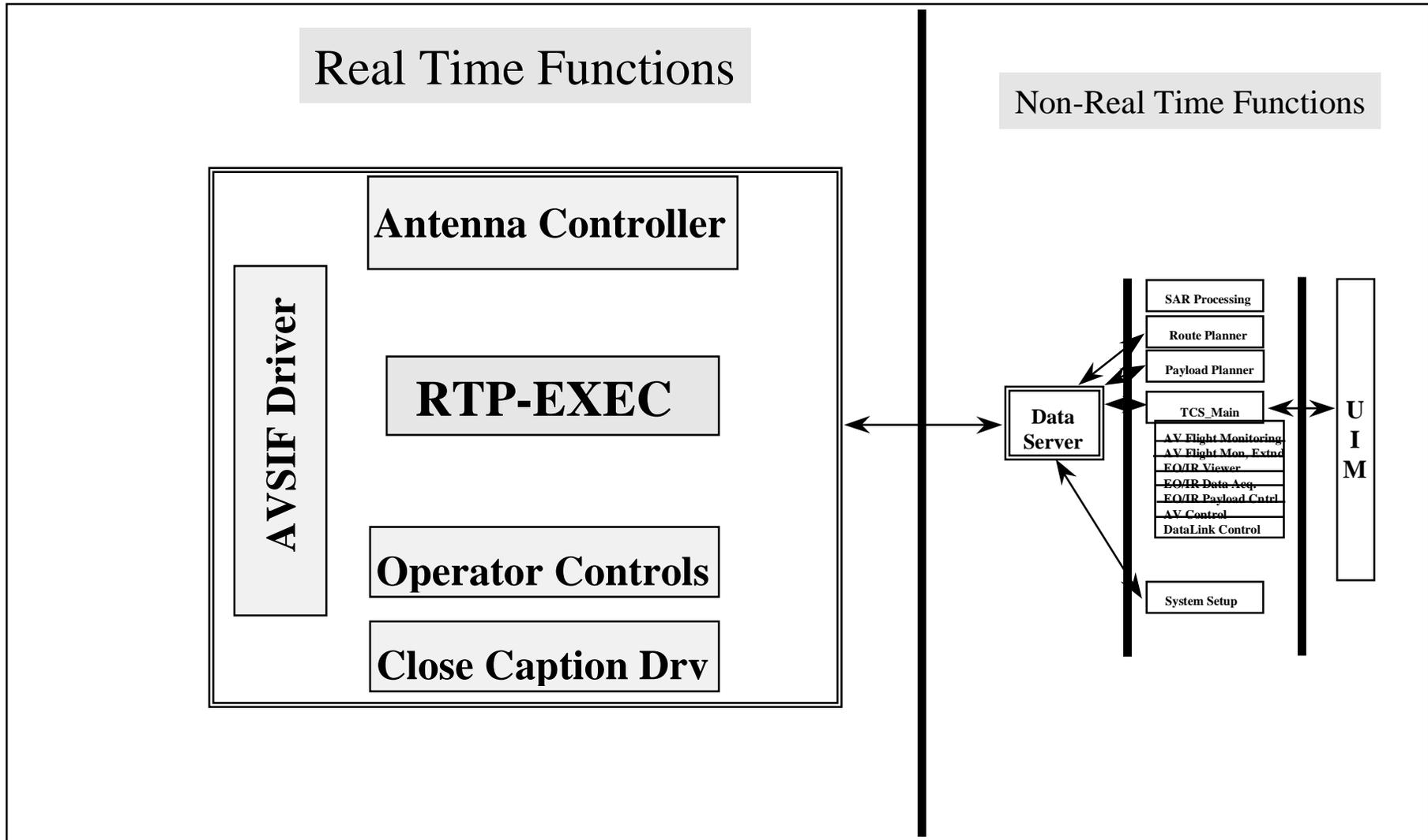


Changes from PDR-Part I

- Deletion of RTP_Link & RTP_DS
 - After install and checkout of the VME networking back plane software, performance analysis indicated no design benefit to having a DataServer local on the RTP.



RTP Block Diagram



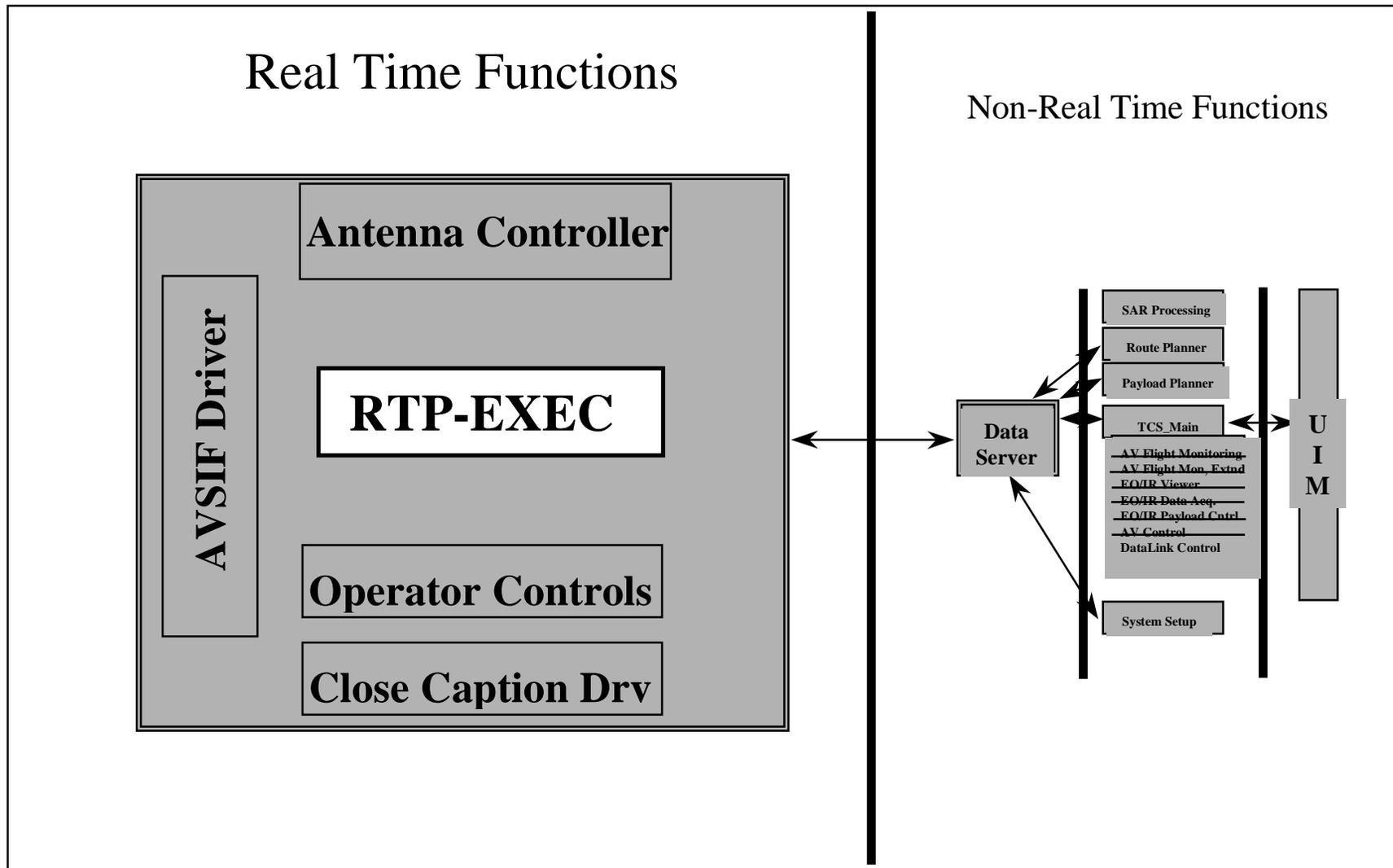


RTP CSCs

- RTP-Exec CSC
 - Startup and shutdown CSCs running on RTP Hardware
- AVSIF CSC
 - Implements the real-time interface with the DCM to receive, transmit, and interpret data from the AV
- Antenna Pedestal CSC
 - Implements the real-time interface with the Antenna Pedestal Controller to point the Antenna
- Operator Controls CSC
 - Implements the real-time interface with the Joystick to provide “stick” data for AV and Payload commands
- Closed Caption CSC
 - Implements closed captioning of NTSC live video



RTP Executive CSC





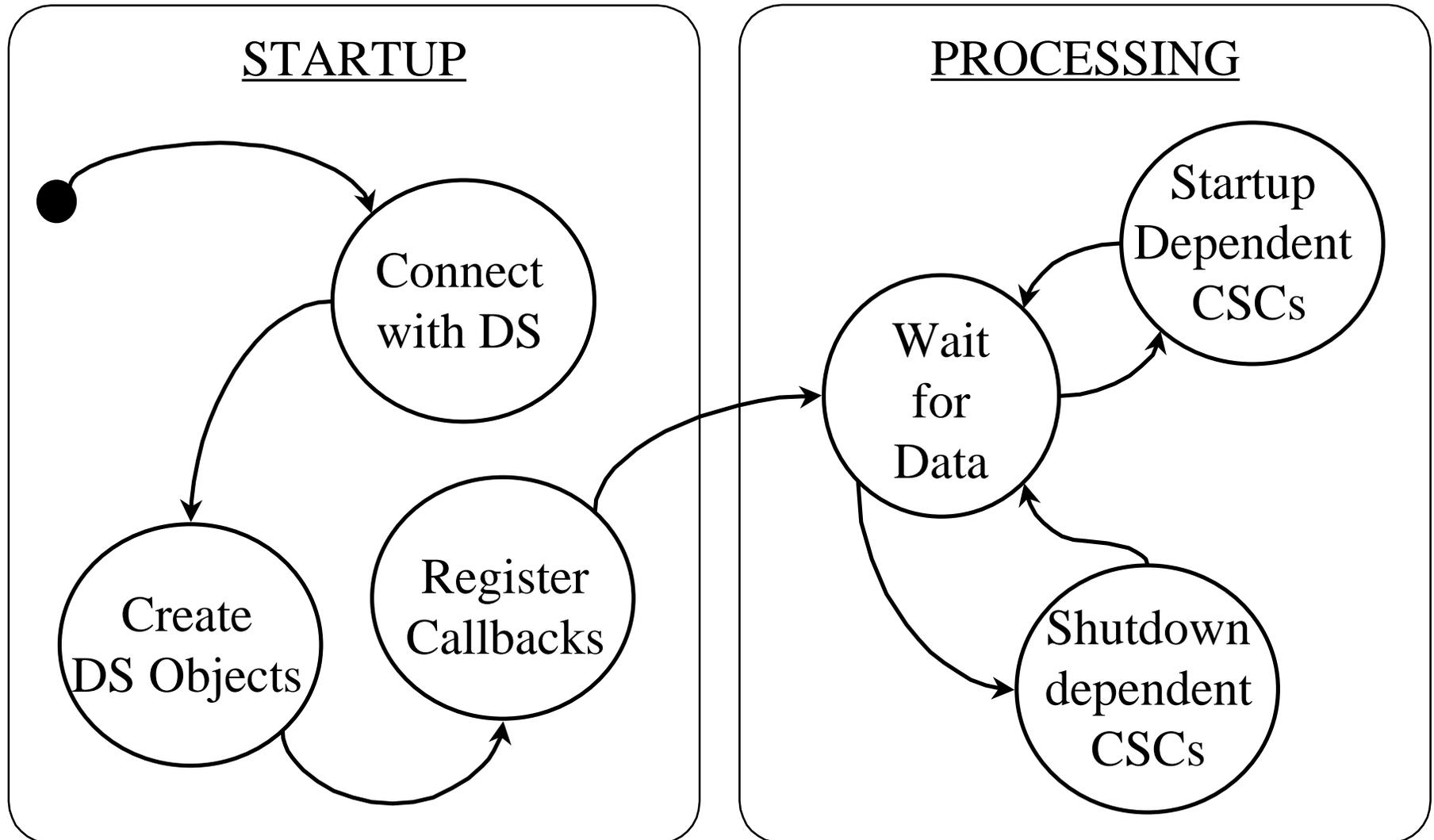
RTP Executive CSC

- CSC Name: RTP-Exec
- Function:

Startup and shutdown CSC running on RTP hardware.
- External Interfaces: Data Server.

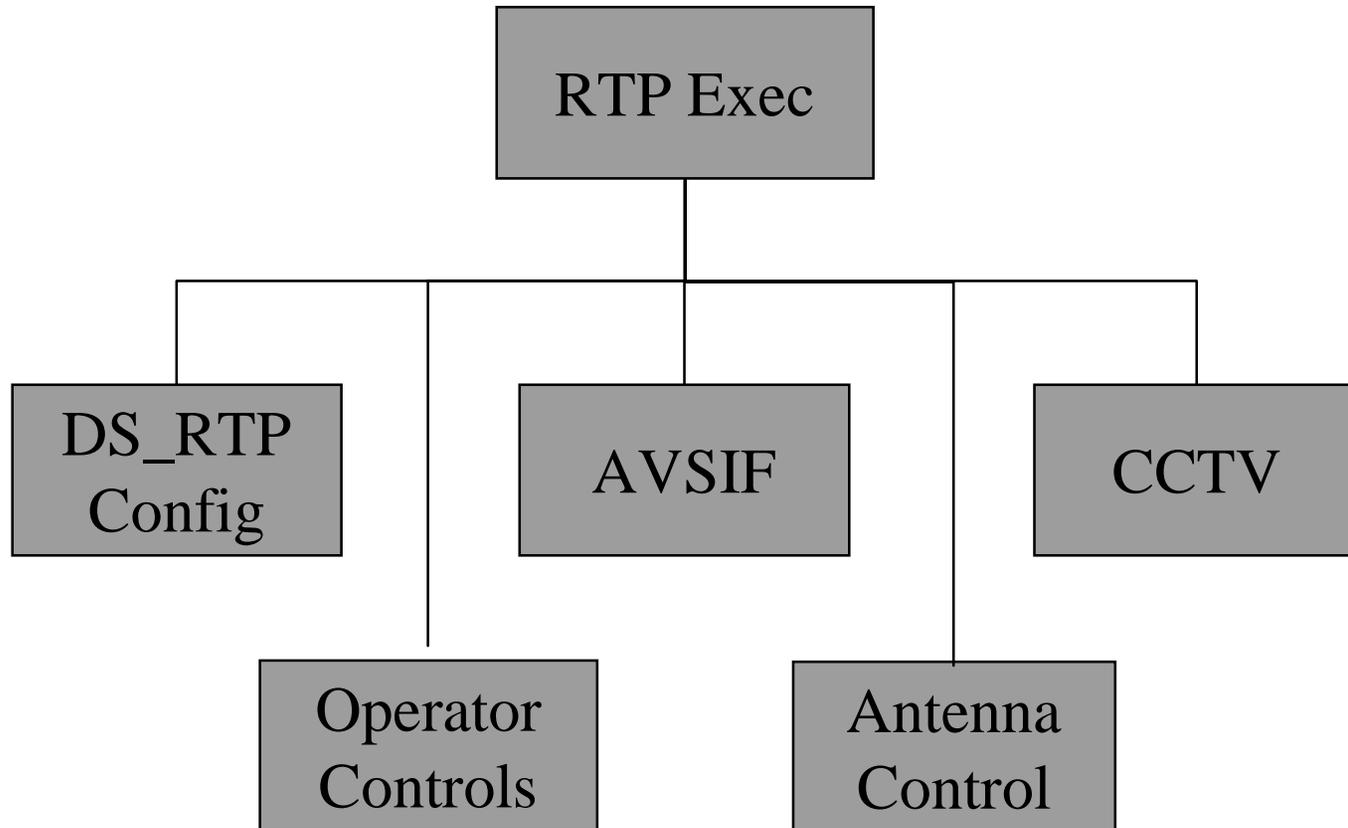


State Diagram





Block Diagram



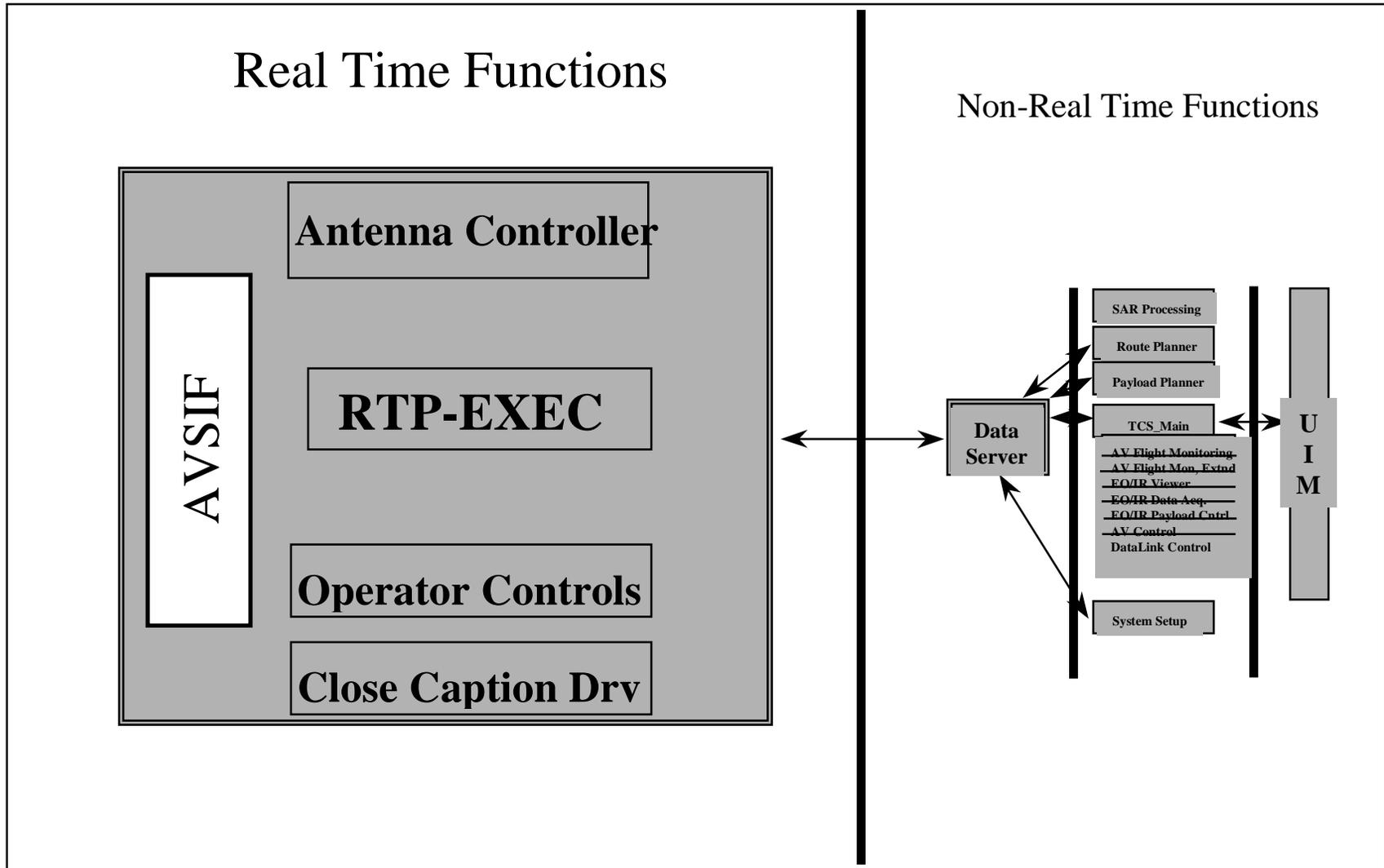


RTP EXEC - Inputs/Outputs

<u>AVSI</u> <u>Message</u>	<u>DS</u> <u>Bucket</u>	<u>Group</u>	<u>Access</u>	<u>HCI</u> <u>Object</u>
n/a	DS_RTP _Config	Admin	Read/Write	N/a



AV Standard Interface CSC





AV Standard Interface

- CSC Name: avsisf
- Function: This application provides the real-time gateway between the Datalink Control Module (DCM) and the nonreal-time portions of TCS through an implementation of the AV Standard Interface message-passing protocol.



Data Use

- One-to-One correspondence between AVSI messages and the message buckets.
- Two data groups used
 - Messages group: Contains AVSI message buckets which define the form and content of the interface full messages. Also used for data logging.
 - Mission group: Contains AVSI message buckets specific to the current mission and AV.
- The Message Support List bucket
 - Defines the messages supported for a particular mission and the version number for these messages.
 - Contained in the Mission data group.

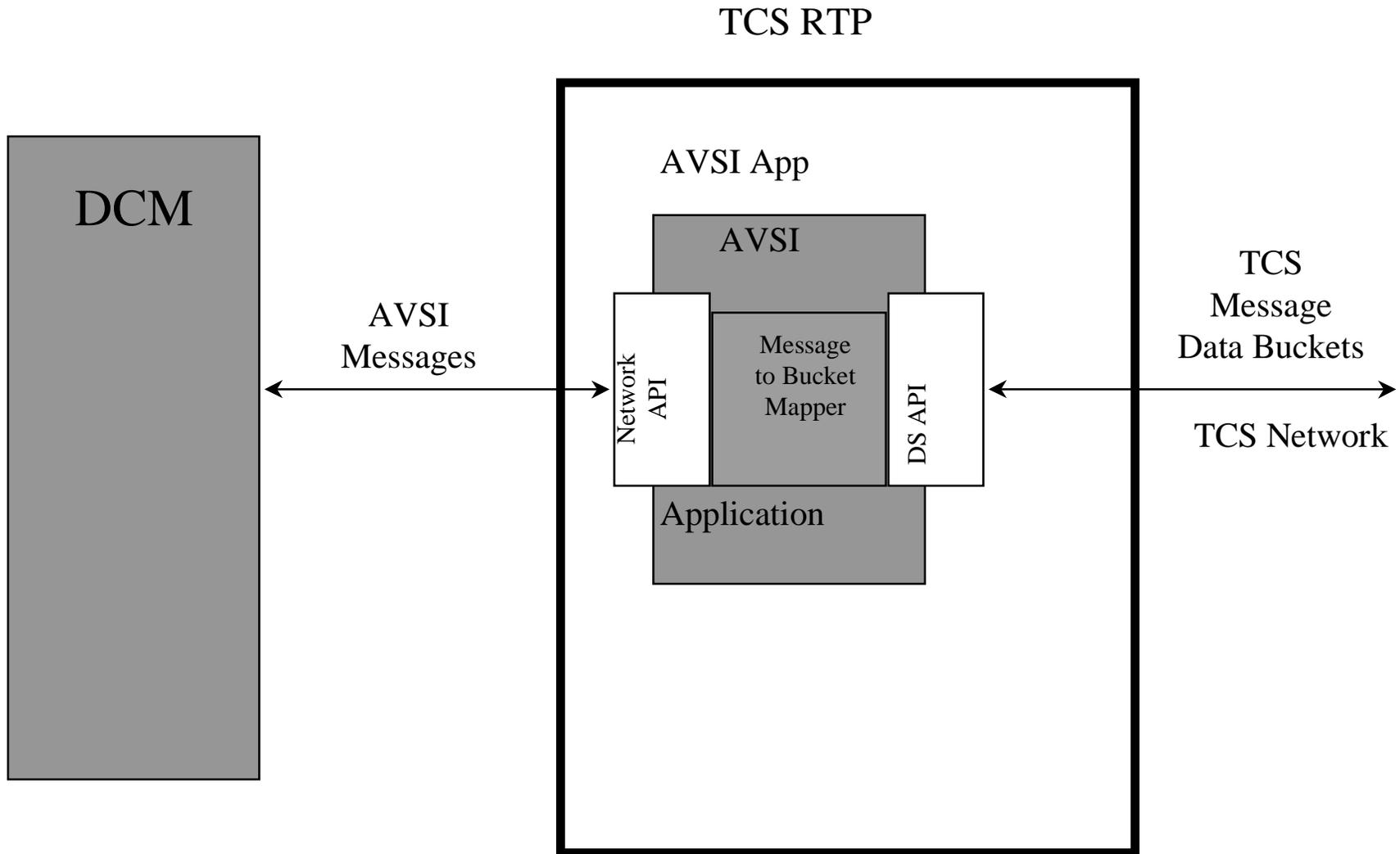


Data Matrix

AVSI Message	DS Bucket	Data Group	Use (Read)	Update (Write)	HCI Object
N/A	Message_Support_List	Mission	Yes	No	N/A
AV Position Status	AV_Position_Status	Mission, Messages	No	Yes	N/A
AV INS Status	AV_INS_Status	Mission, Messages	No	Yes	N/A
AV EOIR Status	AV_EOIR_Status	Mission, Messages	No	Yes	N/A
AV Fuel Status	AV_Fuel_Status	Mission, Messages	No	Yes	N/A
DCM Mission Load Acknowledge	DCM_Mission_Load_Acknowledge	Mission, Messages	No	Yes	N/A
AV Flight Mode Command	AV_Flight_Mode_Command	Mission, Messages	Yes	No	N/A
AV Waypoint Begin	AV_Waypoint_Begin	Mission, Messages	Yes	No	N/A
TCS Position Uplink	TCS_Position_Uplink	Mission, Messages	Yes	No	N/A

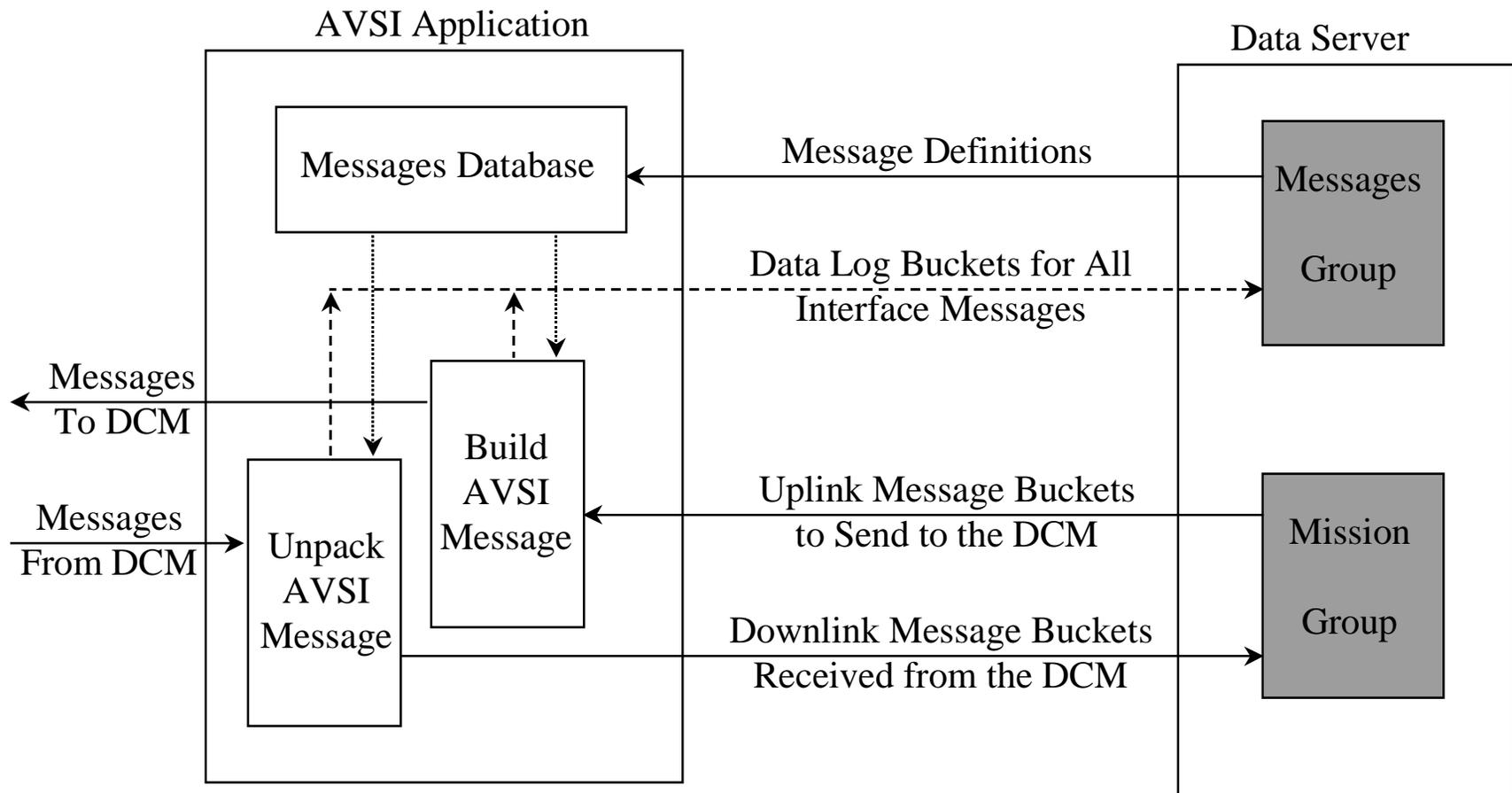


Block Diagram





Data Flow



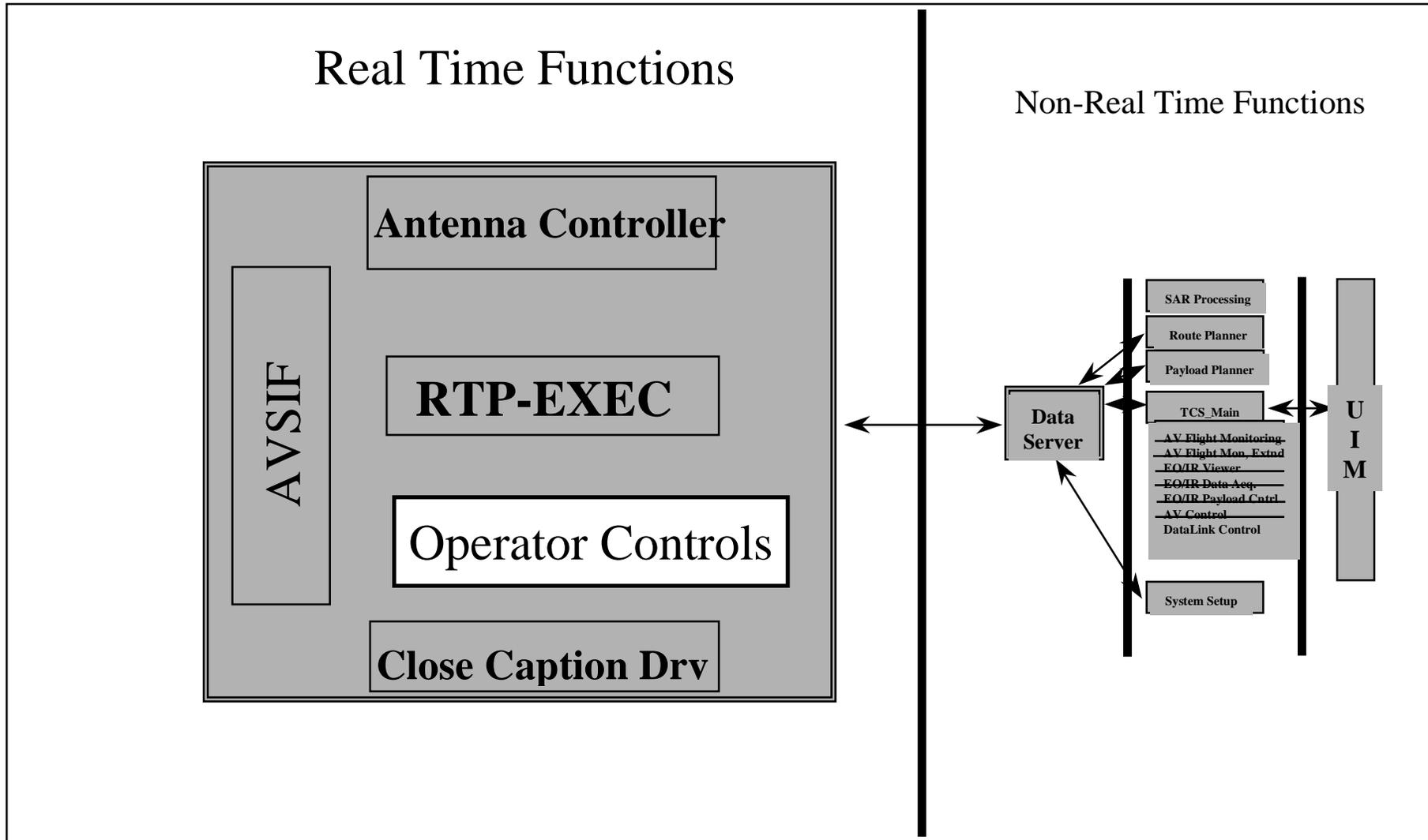


Operation

- Determine the messages supported by the DCM for the current mission by accessing the Message Support List data bucket.
- For each supported message, create the corresponding message bucket in the Messages group and use it to determine the structure and content of the interface message.
- In the Mission group, create the mission-specific data bucket corresponding to each supported AVSI message and determine the mapping between message data content and the data elements in that bucket. Also subscribe to each data bucket corresponding to an uplink (TCS to DCM) message.
- Save all of the information about the messages and the data buckets in the avsif Messages Database, which drives all of the other message/bucket processing within avsif.
- Establish the connection to the DCM. If avsif cannot make this initial connection, or if it loses the connection at a later time, it will attempt to (re)connect periodically (every two seconds).
- Upon receipt of a message from the DCM:
 - Load the message data into the corresponding mission-specific data bucket and send it to the Data Server. This load may contain only a subset of the full message data, depending on the AV's use of the message.
 - Also load **all** of the message data into the message logging data bucket and send that bucket to the Data Server
- Upon receipt of a mission-specific data bucket subscription from the Data Server:
 - Load the data from the bucket into the corresponding message and the message logging data bucket.
 - Set any message fields that do not receive data from the bucket to an appropriately formatted zero value. Also enter these values into the message logging data bucket.
 - Subscription receipt (continued):
 - Send the message to the DCM.
 - Send the message logging data bucket to the Data Server.
- On a shutdown command or on lose of the connection to the Data Server, close all of the interfaces in an orderly fashion and terminate gracefully.



Operator Controls CSC





Real-Time Operator Controls CSC

Name: Real-Time Operator Controls

Description:

Periodically (10/20 Hz) obtains current values from TCS RT operator hardware device(s) via RS-232 line, re-scales values to meet DCM's requirements, and package the data in a format appropriate for the DCM. The is sent to the AVSIF via the DS for transfer to the DCM.

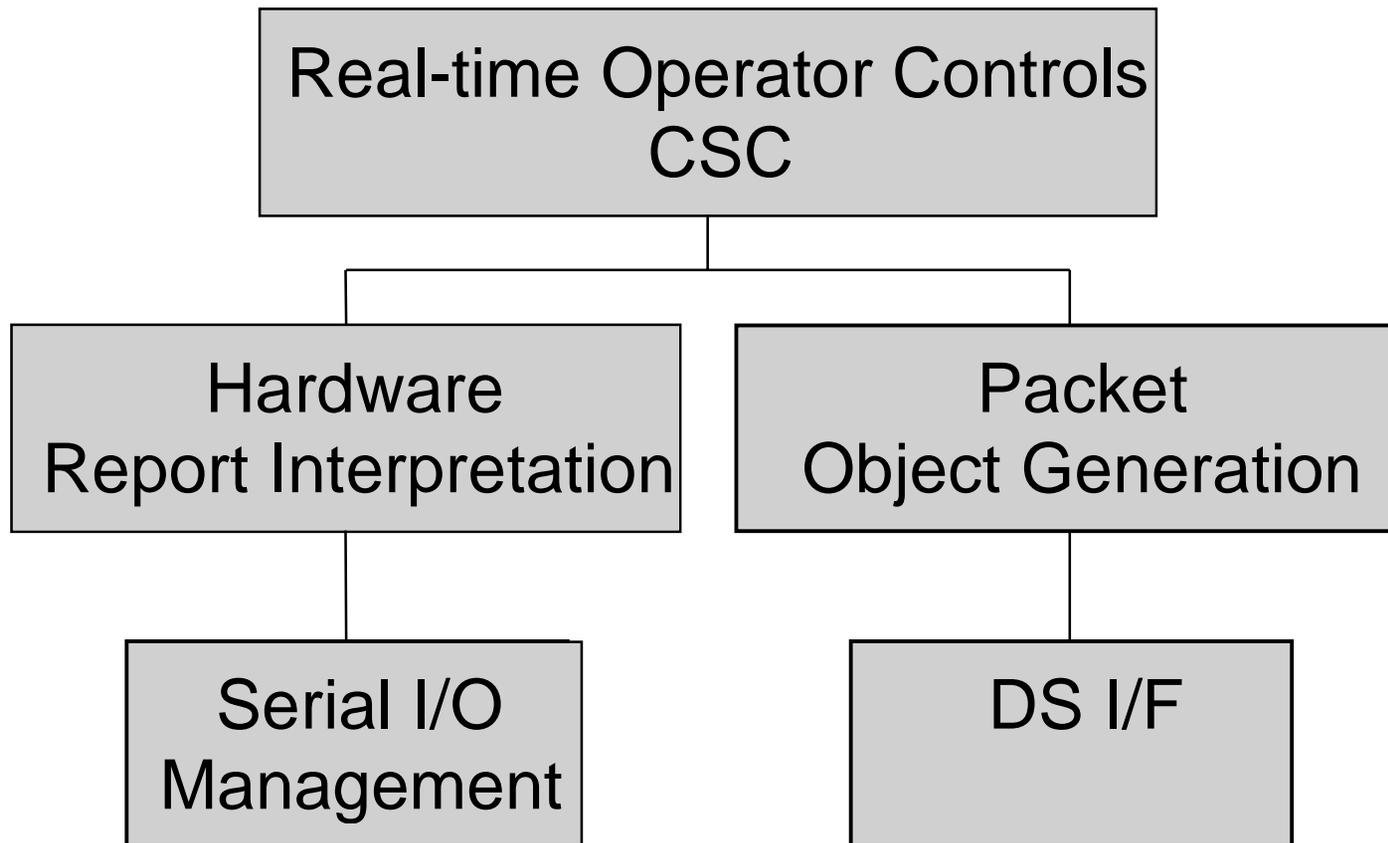
(Under construction)

Interfaces:

(1) RS-232 Serial line. (2) DS



Real-Time Operator Controls CSC Block Diagram





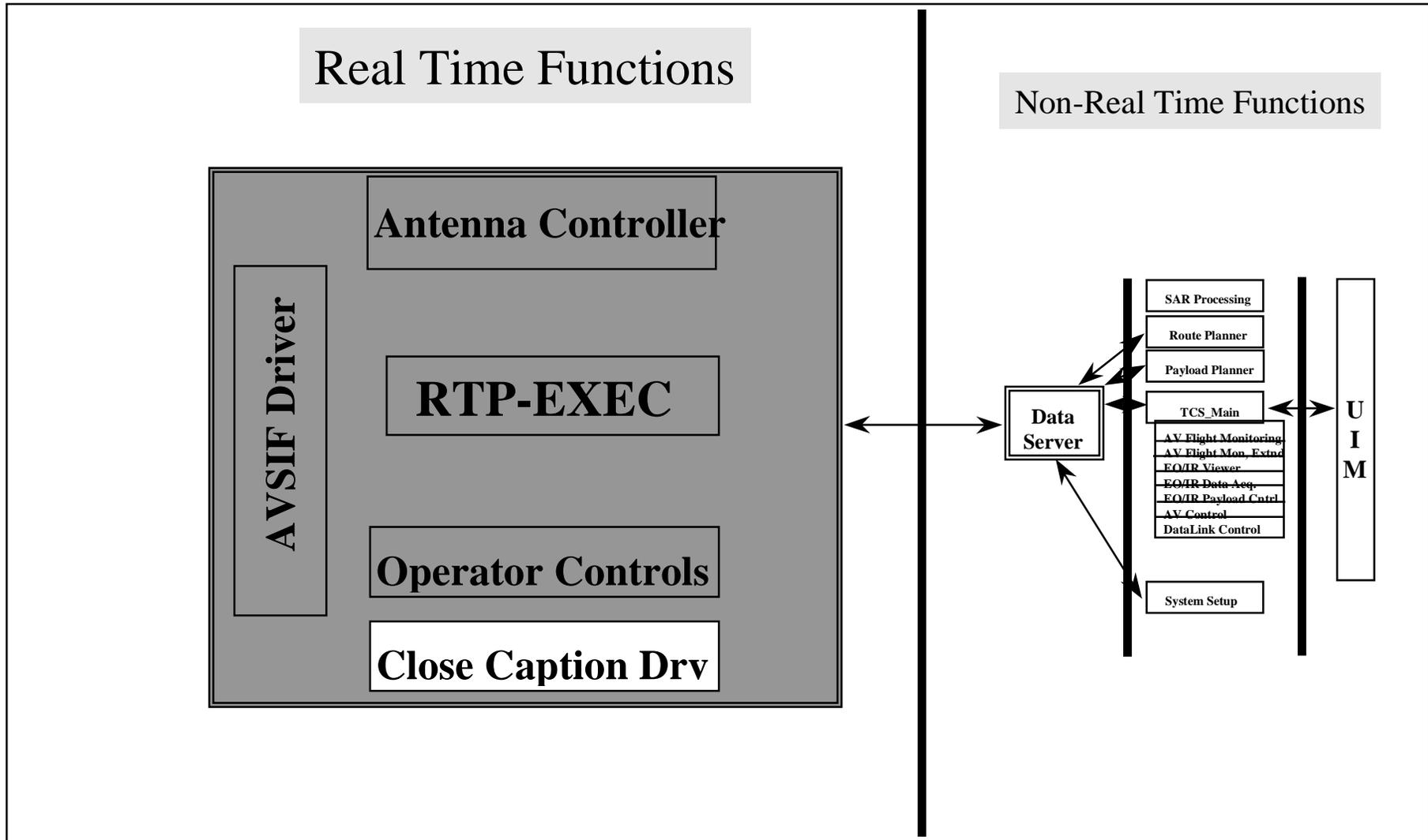
Real-Time Operator Controls CSC Data Movement

From RT Hardware to DS:

DS_RT_Operator_Controls



Closed Caption CSC



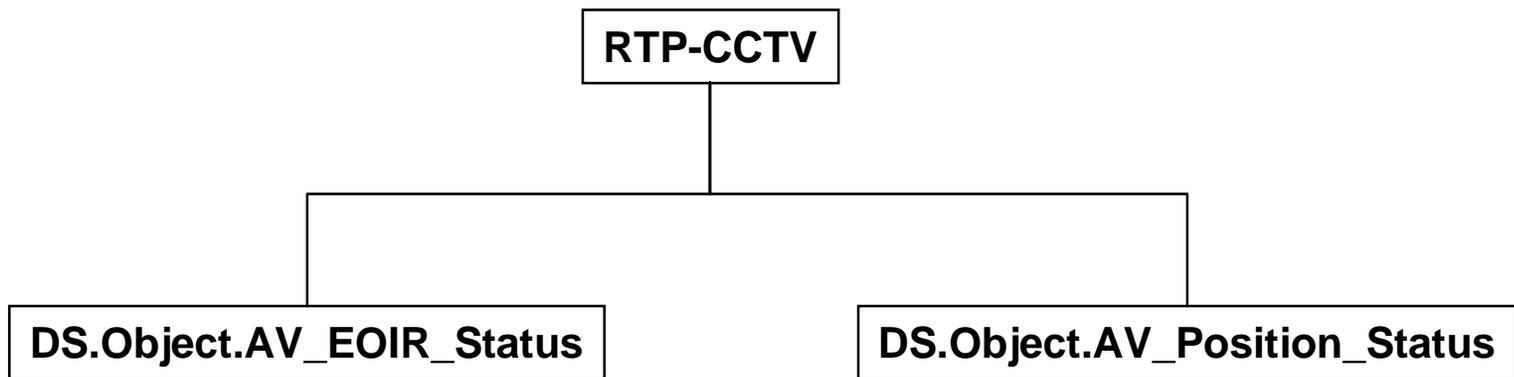


RTP-Close Caption CSC

- CSC Name: RTP Closed Caption Television Encoder/Annotator (RTP-CCTV)
- Function:
 - Adds near real time captions to payload video for CCTV consumers.
 - Adds Parseable Exploitation Support Data (PESD) which can be extracted in support of imagery exploitation. (This data does not appear on the screen.)



RTP-CCTV Block Diagram





RTP-CCTV Data Matrix

<u>AVSI Message</u>	<u>DS Bucket</u>	<u>Group</u>	<u>Access</u>
AV EOIR Status	AV_EOIR_Status	Mission	Read
AV Position Status	AV_Position_Status	Mission	Read
n/a	CCTV Tables	Admin	Read



Data Use

- The RTP-CCTV is a display-only application. Information flows only one direction: from the Data Server to the video stream.
- Processes Data Server objects as they are received from the AV Standard Interface (1 to 10 Hertz).
- Updates graphical display at 1/3 Hertz.
 - Slow update rate due to limitations of the CCTV frame buffer.

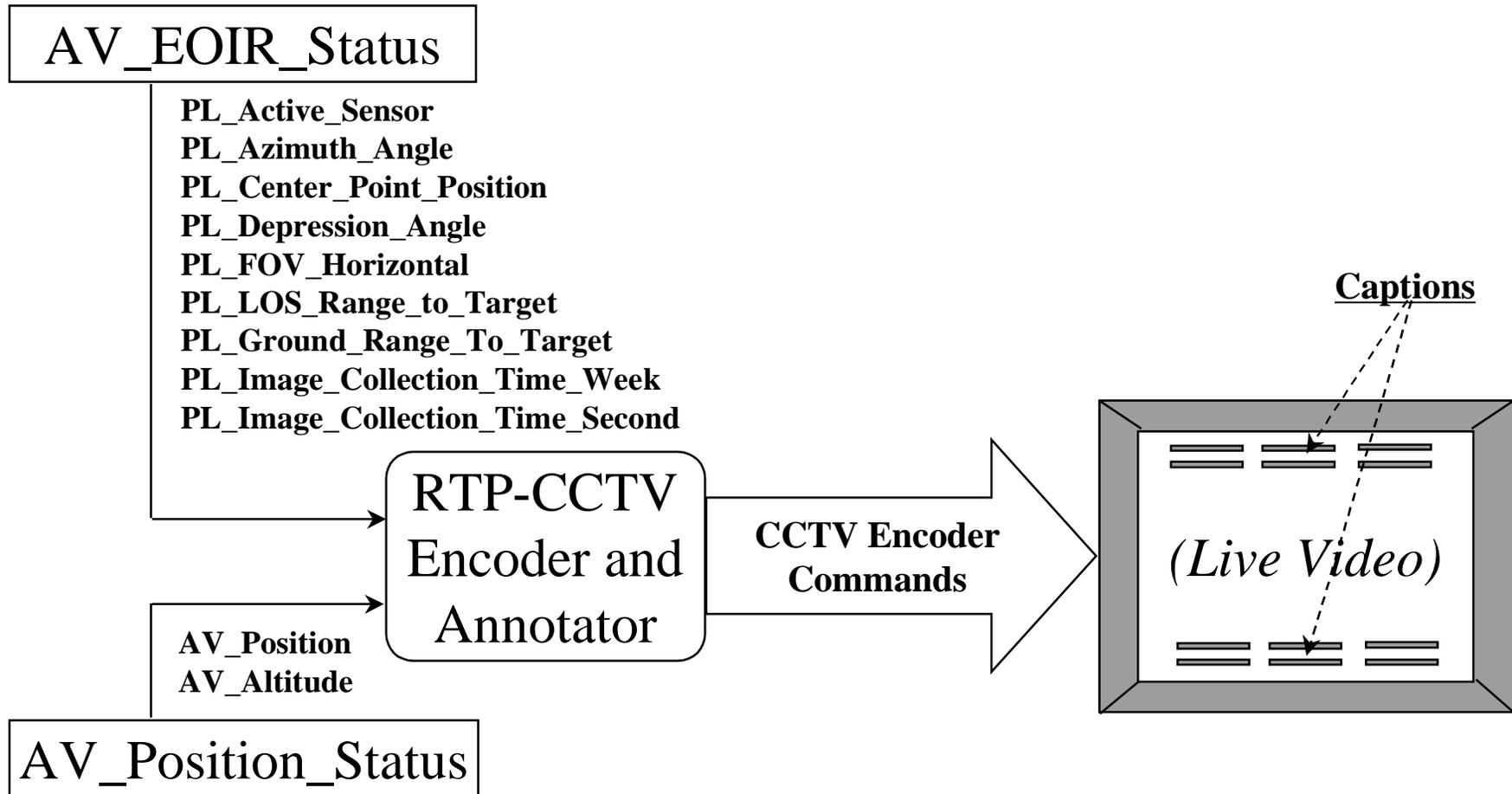


Operation

- Launched by RTP video process.
- Connect to DS; initialize data format and content tables; initialize CCTV encoder.
- Enter main loop:
 - Store and process status data as each subscription arrives.
 - Set internal variables that contain the information for the Closed Captions.
 - At each screen refresh cycle resend all caption fields.
- Shutdown and exit.



RTP-CCTV Data Flow





Visible Captions

- Center Field of View Latitude
- Center Field of View Longitude
- Image Width
- Center Field of View Slant Range
- Line of Sight True Azimuth Angle
- Line of Sight Incidence Angle
- Payload Field of View Horizontal
- Air Vehicle Barometric Altitude
- Air Vehicle Altitude
- Air Vehicle Latitude
- Payload Name - Payload Active Sensor
- Image Date/Image Time (Alternating)

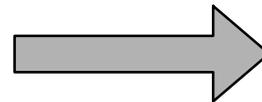


PESD Fields

- Center Field of View Latitude
- Center Field of View Longitude
- Image Width
- Center Field of View Slant Range
- Line of Sight True Azimuth Angle
- Line of Sight Incidence Angle
- Payload Field of View Horizontal
- Air Vehicle Barometric Altitude
- Air Vehicle Latitude
- Air Vehicle Longitude
- Payload Name - Payload Active Sensor
- Image Date/Image Time (Alternating)
- Image Coordinate System
- Mission Number
- Mission Start Date
- Mission Start Time
- Image Classification
- Project ID Code
- ESD ICD Version

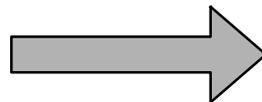
Examples:

Target Latitude: 85°59'59.7"



Ta+8959597

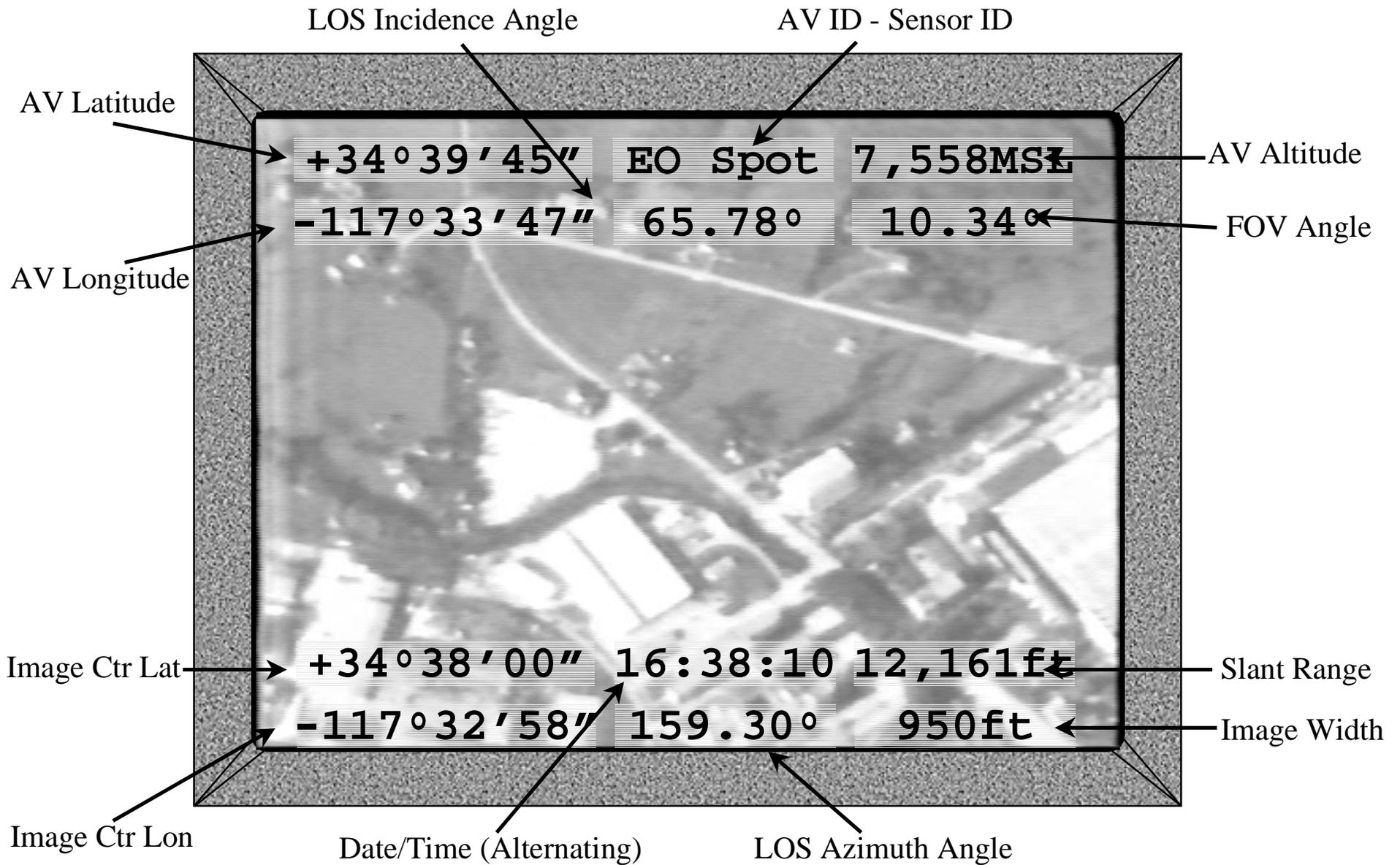
Mission Start Date: 4 Feb 98



Md19980204

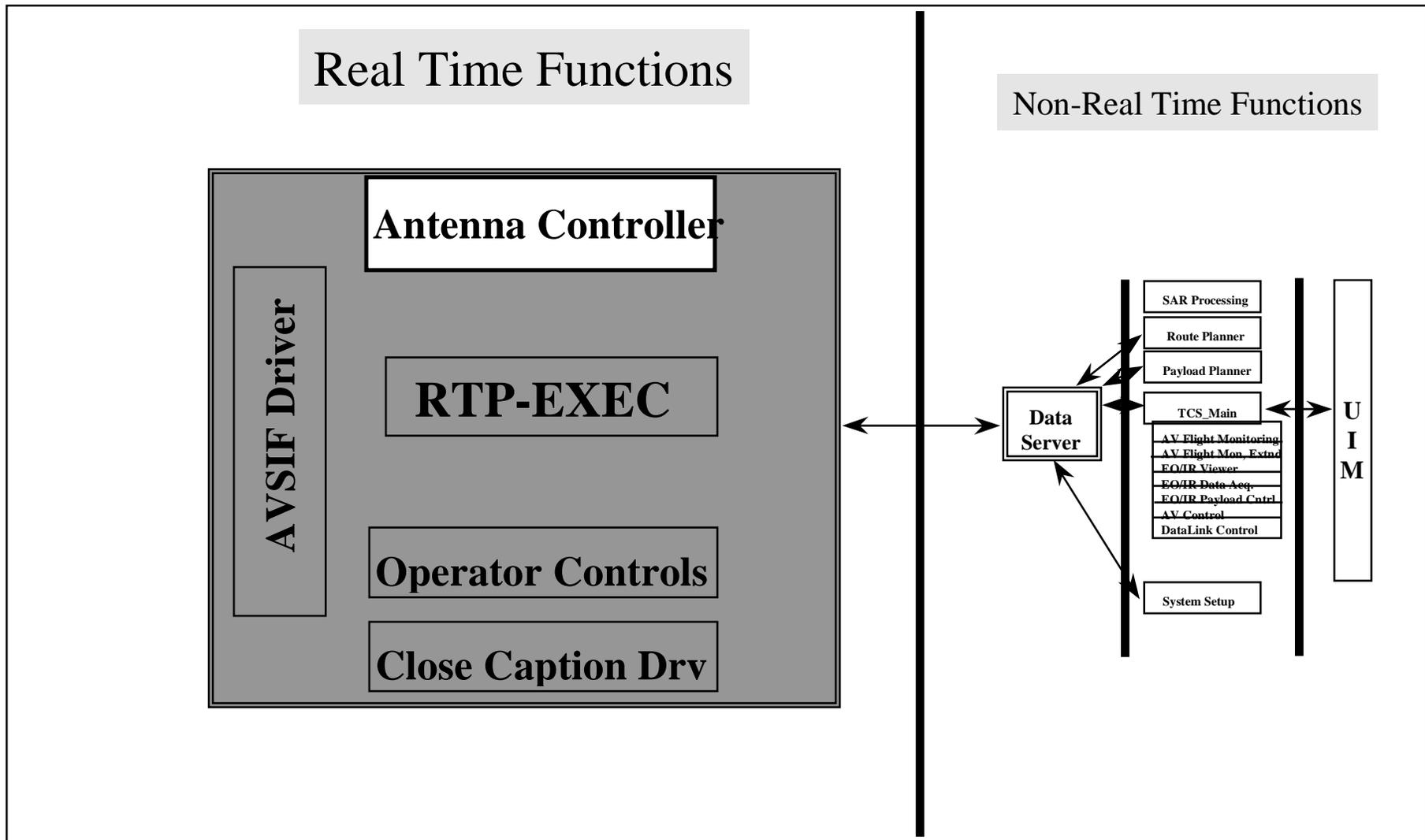


Example Visible Captions





Antenna Controller CSC





RTP Antenna Controller CSC

Name: RTP Antenna Controller

Description:

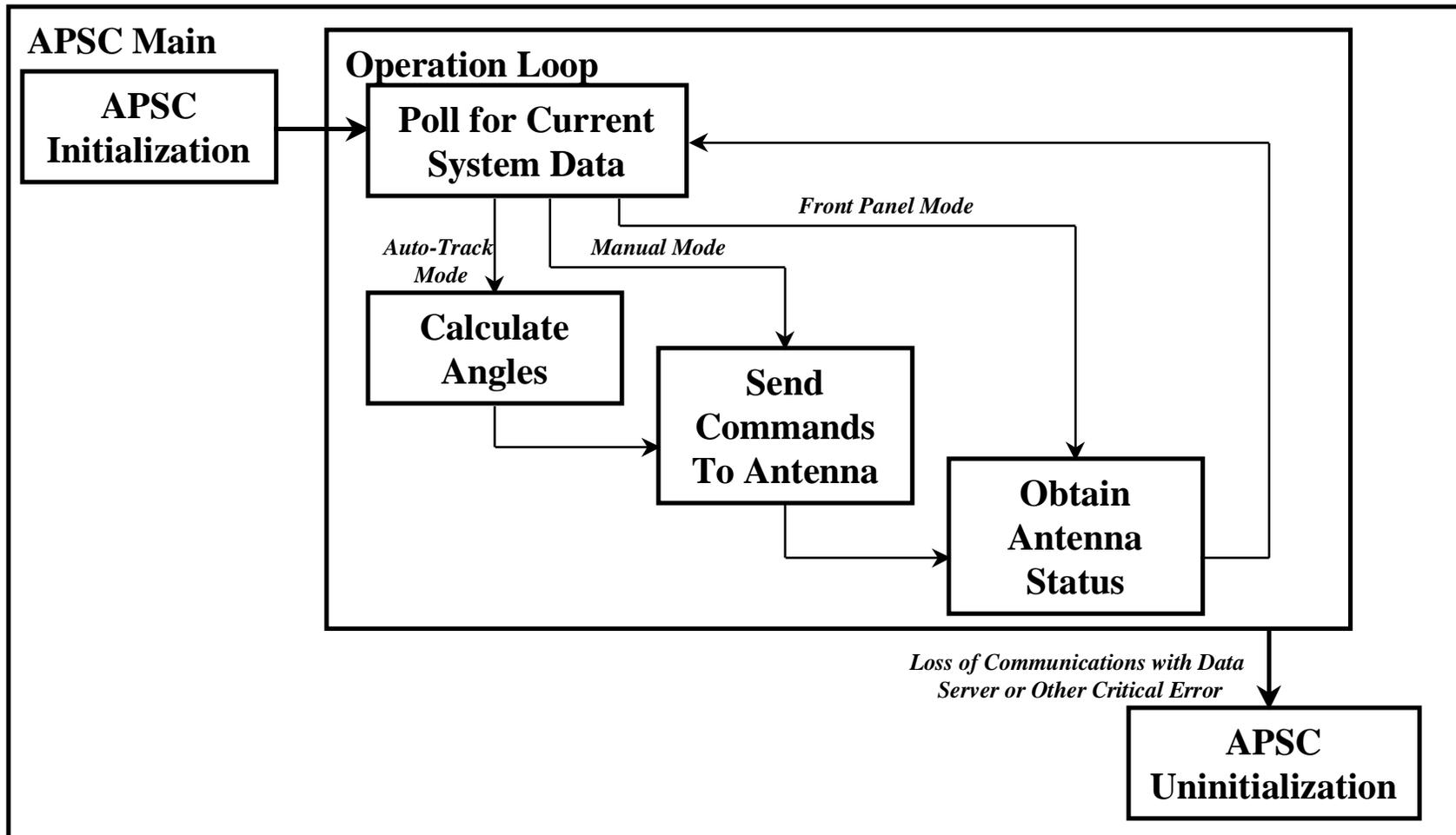
Provide the communication interface between the TCS and the TAC-92/Antenna assembly. Calculate angles/direction for the Antenna to point to insure clear communications between the UAV and TCS. Monitor and report the Antenna's status.

Interfaces:

TAC-92, DS



RTP Antenna Controller Block Diagram





RTP Antenna Controller

Input Data Elements

Antenna Commands

True Azimuth (Degrees) - Used for “manually” pointing the antenna. Specifies an azimuth to point the antenna in relation to “true” north (0-360.0).

Elevation (Degrees) - Used for “manually” pointing the antenna. Specifies an elevation upangle to point the antenna (0-90.0).

Antenna Designation - A selection that determines whether the Directional (high gain) or Omni (low gain) antenna should be active.

Antenna Frequency - A selection that determines whether UAV/TCS communications should be using the designed High or Low Frequency bands.

Pointing Mode - A selection that determines whether APSC only reports antenna status (Front Panel Mode), points the antenna using the manual commands shown above (Manual Pointing), or calculates the pointing angles based on TCS and UAV position (Auto-Tracking Mode).



Input Data Elements (cont'd)

Antenna Commands (cont'd)

Earth Model - A selection that determines what Earth Model APSC should use when calculating pointing angles in “Auto-Tracking” Mode. (Flat Earth Model, Spherical Earth Model, Spherical Earth Model with Atmospheric Deflection).

Stabilization Mode - A selection that determines whether APSC continually supplies the antenna/TAC-92 with heading updates (Software controlled) or only updates the heading periodically (Hardware controlled). Hardware control is used when the system is aboard a moving platform and heading synchro lines are available.

Auto Unwrap - A selection that determines whether the antenna should automatically “unwrap” when the antenna approaches its end stops.

Force Unwrap - Allows the user to perform an “unwrap” early, if so desired.

Azimuth Offset (Degrees) - An angle added to all commanded azimuth angles to correct for installation/boresighting errors or antenna pattern anomalies.

Elevation Offset (Degrees) - An angle added to all commanded elevation angles to correct for installation/boresighting errors or antenna pattern anomalies.



Input Data Elements (cont'd)

Antenna Position

Latitude (Degrees) - **The Latitude of the TCS. Primarily used for calculating pointing angles in “Auto-Track” Mode (-90.0 - 90.0).**

Longitude (Degrees) - **The Longitude of the TCS. Primarily used for calculating pointing angles in “Auto-Track” Mode (-180.0 - 180.0).**

Altitude (Feet) - **The altitude of the TCS. Used to calculate “Auto-Track” pointing angles.**

Heading (Degrees) - **The current Heading of the TCS w/respect to True North. Passed to TAC-92/Antenna (0.0-360.0).**

UAV Position

Latitude (Degrees) - **The Latitude of the UAV. Primarily used for calculating pointing angles in “Auto-Track” Mode (-90.0 - 90.0).**

Longitude (Degrees) - **The Longitude of the UAV. Primarily used for calculating pointing angles in “Auto-Track” Mode (-180.0 - 180.0).**

Altitude (Feet) - **The altitude of the UAV. Used to calculate “Auto-Track” pointing angles.**

Heading (Degrees) - **The current Heading of the UAV w/respect to True North. (0.0-360.0)**



RTP Antenna Controller

Output Data Elements

Antenna Status

True Azimuth (Degrees) - **Current azimuth of Antenna in relation to “true” north (0-360.0).**

Elevation (Degrees) - **Current elevation of Antenna (0-90.0).**

Relative Azimuth (Degrees) - **Current azimuth of Antenna in relation to “bow”/midpoint of pointing azimuth range (-270.0 - 270.0).**

Temperature (Degrees F) - **Current temperature of the Antenna pedestal (-58.0 - 212.0).**

Range to AV (Nautical Miles) - **Current range to Air Vehicle (0-6553.5).**

True Bearing to AV (Degrees) - **Current bearing to Air Vehicle with respect to “true” north (0.0-360.0).**

Antenna Designation - **The current antenna in use. Either the Directional (high gain) or Omni (low gain) antenna.**

Antenna Frequency - **The frequency band that is currently being used for UAV/TCS communications (HIGH or LOW).**



Output Data Elements (cont'd)

Antenna Status (cont'd)

Pointing Mode - **The currently active pointing mode. (Front Panel, Manual, Auto-Tracking).**

Near Lower Limit - **A status variable describing whether the antenna is near its lower end-stop. (True/False).**

Near Upper Limit - **A status variable describing whether the antenna is near its upper end-stop. (True/False).**

Stabilization Mode - **APSC's current condition for sending the TAC-92/Antenna assembly heading updates (Hardware, Software).**

Unwrap In Progress - **A status variable describing whether the antenna is currently “unwrap”-ing. (True/False).**

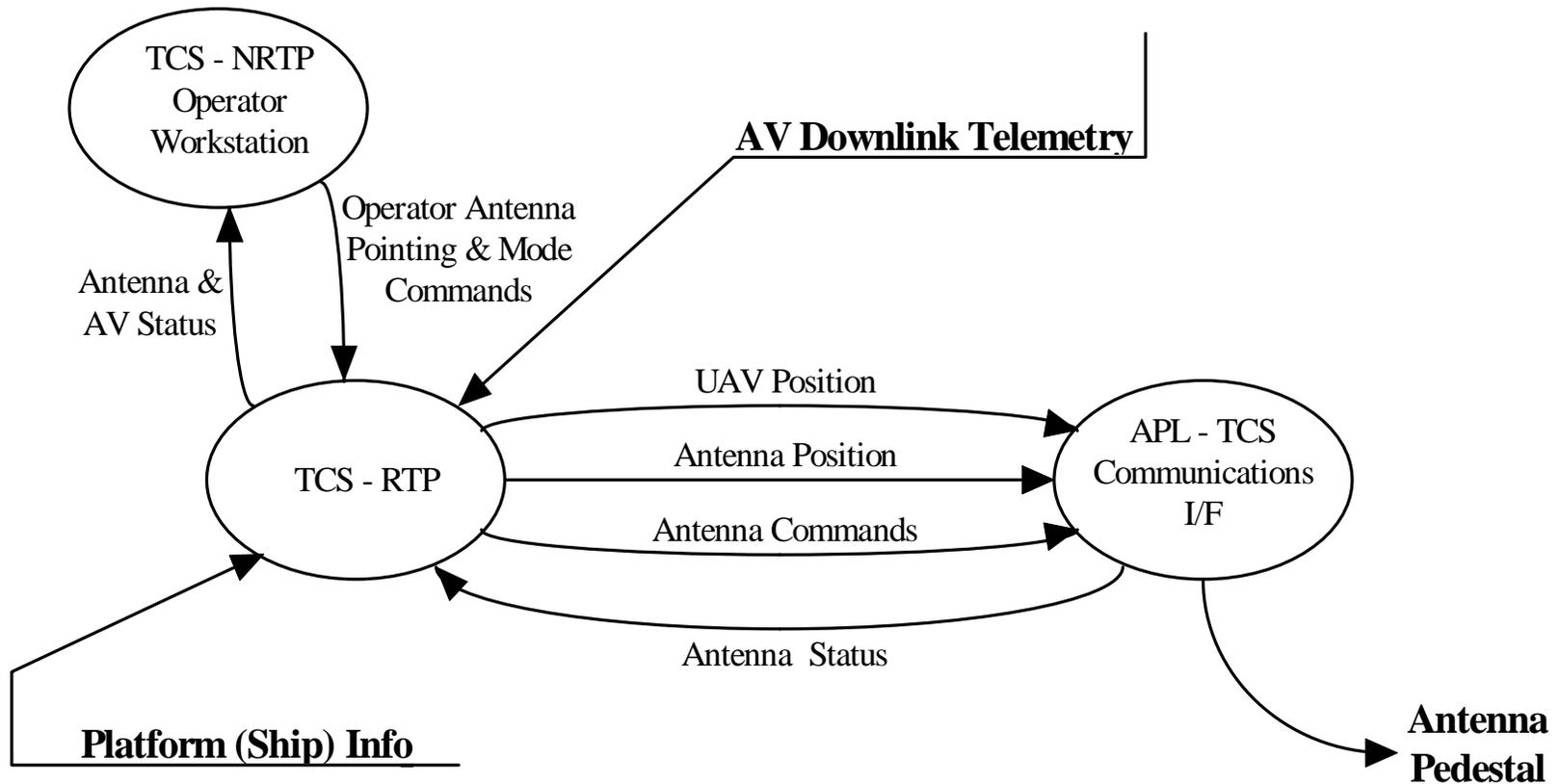
Auto Unwrap - **Current “auto-unwrap” mode of the antenna (On, Off).**

Initializing - **A boolean describing whether the antenna is currently initializing. (True/False).**

Error Detected - **A boolean describing whether an antenna error was detected. (True/False).**



RTP Antenna Control Data Flow





Antenna Controller

Earth Model Algorithms

- **Flat Earth Model**

Simple Earth model that calculates pointing angles using basic trigonometry operating on flat planes.

- **Spherical Earth Model**

Earth model that calculates pointing angles using trigonometric functions operating on a spherical surface.

- **Spherical Earth Model with Atmospheric Deflection**

Most accurate Earth Model that calculates pointing angles using a similar process as the Basic Spherical Earth Model. Calculated angles are modified by taking into account the refractive coefficients of the Earth's atmosphere. (Most commonly used)